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A PROMISING DIRECTION IN THE PRODUCTION OF SANITARY WARE

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A comparative analysis of the composition and properties of plastic and flexible slips is given. It is concluded that conversion from plastic to lean slip is needed in order to provide competitiveness of domestic products on the world market and produce state-of-the-art sanitary ware.

The technology of sanitary-ware production that existed in our country by the beginning of the 1990s complied with the standards GOST 22847–77 and GOST 21485.0-5–76, which prescribed the shape and design of products. According to this technology, a patch was attached on the bottom of a toilet bowl with a slanting outlet. In a toilet bowl with a straight outlet, the entire bottom was glued. In the production of a flush tank, the lateral pouring gate was healed.

In order to perform the operations of healing and attachment of parts, the slip has to have high plasticity by virtue of a high content of clay and kaolin in the slip composition. In practice, the slip plasticity is evaluated using a parameter such as the dispersion assessed by GOST R 50298.0–92.

The Ekaterinburg Factory of Ceramic Products uses filter-pressed slip of the following composition (%) for this type of product: 23.5 Druzhkovskoe clay DN-0, 20.5 Kyshtymskoe sand, 22.0 Vishnevogorskoe pegmatite, 4.0 waste of fired glass, 13.0 wet-concentrated Prosyanovskoe kaolin, 17.0 wet-concentrated Glukhovetskoe kaolin, 0.65 soluble glass with a silicate modulus of 3 and a density of 1.3 g/cm^3, and 30.0 – 32.0 water. The residue on a No. 0063 sieve is 2.5%, and the dispersion is 35 – 37%.

The indicated slip has the following parameters determined by methods developed at the NIIstroikeramika Institute: the slope fluidity is 2 sec, the first fluidity from an Engler viscosimeter (500-ml volume and 6-mm hole diameter) after 30 sec is 7 sec, the second fluidity after 30 min is 14 sec, and the setting on a gypsum dish with 30% water absorption is 30 – 33 g in 5 min.

In using the Galencamp viscosimeter, adopted in Europe, the twisting angle for this slip after 5 sec is 165 – 180°, and the thixotropy (the difference between the twisting angles after 5 sec and after 5 min) is 65 – 90°.

Sanitary-ware products manufactured in the West have a more complex shape and do not contain attached pieces, which calls for the use of less plastic and more flexible slips. Moreover, it is impossible to empty a complex mold of a plastic slip. The slip remains in all the corners and narrow spots, and subsequently due to the difference in the moisture content of the set layer and the slip that has not been cast, cracks appear in the article in drying. Such products are impossible to heal or decorate in repeated firing.

Italian manufacturers currently use slip of 300 – 320° viscosity and 30 – 40° thixotropy (by the Galencamp viscosimeter). It is not correct to evaluate such slip using the NIIstroikeramika methodology, since the first fluidity here is less than 3 sec, and the slope fluidity is less than 1 sec.

The only factory in Russia built by Italians and using slip with the required parameters (viscosity 300°, thixotropy 40°) is located in Staryi Oskol. This factory has achieved the necessary dilution of the slip by a maximum possible decrease in the content of the plastic components and by introducing rheotan (an Italian electrolyte) or the domestic electrolyte PAN.

Russian producers currently tend to procure caps (die molds) made by SISA (Italy). Production of state-of-the-art complex articles calls for conversion from plastic to lean flexible slip.

The Ekaterinburg Factory of Ceramic Products has developed a lean non-filter-pressed slip for casting on "Alpha" manual casting stands on the basis of Italian die molds (SISA). The slip composition is as follows (%): 20.5 Druzhkovskoe clay DN-0, 26.0 Kyshtymskoe sand, 21.0 Vishnevogorskoe pegmatite, 7.5 waste of fired glass, 6.5 Prosyanovskoe kaolin of wet concentration, 18.5 wet-concentrated Glukhovetskoe kaolin, 0.3 soluble glass with a silicate modulus of 3 and a density of 1.3 g/cm^3, 0.075 soda, 0.015 barium carbonate, 0.00725 sodium carboxymethyl cellulose, and 30.0 – 32.0 water. The presence of soda and barium carbonate electrolytes in the composition is dictated by the absence of a filter-pressing stage.

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The indicated slip had the following parameters: slope fluidity 1.4 sec, first fluidity 4.5 sec, second fluidity 5.6 sec, setting 27 – 29 g, residue 3%, dispersion 29 – 31%, viscosity by a Galencamp viscosimeter 240°, and thixotropy 55 – 65°. However, due to the high viscosity of the slip, the total waste in the production of Alpha articles was rather high (30 – 35%).

Implementation of the new equipment "Vega" (die molds from the SISA company) for mechanized casting of sanitary ceramics required introduction of certain changes in the technology of casting and disassembly and further decrease in the slip viscosity.

In order to achieve the required mobility of the slip, the raw materials have to meet certain requirements. Kaolinite clay ensures strength of setting. By Italian standards its content in the composition has to ensure a strength of the cast and dried intermediate articles at the level of 3.0 – 3.2 MPa.

Russian factories use mostly Veselovskoe and Druzhkovskoe clay from Ukraine. Russian clays are used in small quantities (Latnenskoe LT-1 and Shakhtinskoe VK-1), but their quality is inferior.

The requirements imposed on kaolins, which in essence determine slip mobility, are very stringent. The threshold parameters of structure formation in concentrated kaolins evaluated by GOST 19609.16–79 characterize the dilutability of the kaolins: 1.15 – 1.35 for wet-concentrated Glukhovetskoe kaolin, 1.00 – 1.10 for dry-concentrated Glukhovetskoe kaolin, wet-concentrated Prosyanovskoe kaolin 1.10 – 1.18, and dry-concentrated kaolin from Zhuravlinyi Log 1.10 – 1.13. The structure-formation thresholds in the kaolins shift to larger values as their aging time grows. It is evident that wet-concentrated Glukhovetskoe kaolin is diluted most easily. There are reasons to believe that wet-concentrated Angrenskoe kaolin has good properties, but the data on the latter are still incomplete.

Ceramics factories in Russia use Vishnevogorskoe feldspar and expensive Chupinskoe pegmatite. In spite of the relatively low cost of Vishnevogorskoe feldspar, its potassium modulus has decreased to 0.7 lately and, moreover, it has a high content of black mica grains, which impart a gray color to the crock. At present, production of Malyshevskoe pegmatite has resumed. Its potassium modulus after concentration reaches 1.1 – 1.5, and it is significantly purer than Vishnevogorskoe pegmatite (its mica content is lower). Concentrated pegmatite has to be properly washed of surfactant components introduced in concentration.

Water quality is very important for slip production. By American standards (ASTM), water used for this purpose should meet the following requirements [1]: category A: (Ca + Mg) < 38.5 mg/liter, SO_4 < 25 mg/liter, Cl < 13 mg/liter; category B: (Ca + Mg) < 43 mg/liter, SO_4 < 102 mg/liter, Cl < 18 mg/liter. If such water is not avalilable, an industrial distiller should be installed.

Moreover, the degree of slip pulverizing has an effect on the strength of the cast articles after setting. As the duration of clay milling increases, the strength of the cast article decreases. Thus, when in 1997 the amount of residue on sieve No. 0063 in joint milling of plastic and grog components at the Ekaterinburg Factory of Ceramic Products was decreased from 2.5 to 0.1%, the waste of soured cast articles increased tenfold and reached 30 – 35%. Separate milling of grog materials and diffusion of clay with kaolin make it possible to achieve, with a lower clay content in the composition the same level of fracture strength in articles dried after curing, i.e., using the latter cited composition, the clay content can be reduced by 1.0 – 1.5%, which makes it possible to further decrease the slip viscosity.

Electrolytes play an important role in slip thinning. The combination of soluble glass and sodium polyacrylate is probably most effective. If the stage of filter-pressing of the slip is absent, soda and barium carbonate should be present in the mixture. Since material suppliers do not always guarantee the content of salts dissolved in the material, in order to wash the salts out, it is desirable to filter-press the slip.

It is natural that flexible lean slip calls for certain specifics in the material preparation technology compared to plastic slip and, possibly, leads to replacement of part of the product range, since using this method, it is difficult to attach parts, but an advantage of flexible slip is that it can be used to cast articles of virtually any complexity. These products can be subjected to a decorative second firing or healing. The use of lean flexible slip allows at least five castings per week, as distinct from plastic slip, which allows a guaranteed four castings. In the case of reaching the required mobility of the slip at a density of 1.82 – 1.83 g/cm^3, it is even possible to convert to two castings per day.

Thus, a company that will produce sanitary ware based on flexible lean slip will be able to take a leading place in the industry without large material expenditures.

REFERENCES

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